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NOTES ON GEOGRAPHIC DISTRIBUTION

Eratyrus mucronatus Stål, 1859 (Hemiptera: Reduviidae: Triatominae): First report in the State of Acre, Brazil, and updated geographic distribution in South America

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ABSTRACT: A new occurrence record of *Eratyrus mucronatus* (Hemiptera, Reduviidae, Triatominae) is reported from Rio Branco, Acre, Brazil. The distribution of this triatomine species was updated and a potential geographic distribution map in South America was presented based on ecological niche modeling.

Currently, 145 species are recognized in the subfamily Triatominae (Costa *et al*. 2006; Costa and Felix 2007; Schofield and Galvão 2009; Frías-Lasserre 2010; Rosa *et al*. 2012; Gonçalves *et al.* 2013; Jurberg *et al.* 2013) of which 63 occurs in Brazil (Gurgel-Gonçalves *et al*. 2012; Rosa *et al*. 2012). The genus *Eratyrus* Stål, 1859 is represented by two species: *Eratyrus cuspidatus* Stål, 1859 and *Eratyrus mucronatus* Stål, 1859.

Eratyrus mucronatus occurs in Bolivia, Colombia, Ecuador, Guatemala, Guyana, French Guyana, Panama, Peru, Suriname, Trinidad, Venezuela and Brazil (Carcavallo *et al*. 1999). In Brazil, this species was registered in the states of Amazonas, Tocantins, Maranhão, Mato Grosso, Rondônia and Pará, in humid forest ecoregions (Abad-Franch and Monteiro 2007; Gurgel-Gonçalves *et al*. 2012).

Tree holes, palm trees and rocks are known habitats of *E. mucronatus* in forests (Carcavallo *et al*. 1998b). In nature, nymphs can feed on the haemolymph of arachnids (Amblypygi) inside hollow trees and adults are usually associated with mammals, such as *Coendou prehensilis*, *Didelphis marsupialis* and bats (Carcavallo *et al*. 1998a; Gaunt and Miles 2000).

In the Amazon, invasion of houses by triatomines, apparently related to artificial light sources, should favor transmission of *Trypanosoma cruzi* to humans either by direct contact or by food contamination, especially through *açai* fruit (Coura *et al*. 1999; Valente *et al*. 1999; Nobrega *et al*. 2009; Pereira *et al*. 2009).

According to Morocoima *et al*. (2010) *E. mucronatus* specimens are highly attracted to artificial light sources. In Brazil, *E. mucronatus* has been registered in houses in Manaus (Castro *et al*. 2010) and Rondônia (Meneguetti *et al*. 2011). Furthermore, detection of infected colonies of *E. mucronatus* in houses and peridomiciles has been observed in Bolivia (Noireau *et al*. 1995; Depickère *et al*. 2012), Colombia (Guhl 2007), Peru (Torres and Cabrera 2010) and Venezuela (Rojas *et al*. 2008) indicating the potential risk of transmission of *T. cruzi* to humans. Thus, it is important to record the locations where *E. mucronatus* has been detected in domiciles, as well as update the geographic distribution of this species and predict areas of potential occurrence. In this study we registered a new occurrence of *E. mucronatus* in Brazil, updated its distribution and analyzed its potential geographic distribution in South America.

In November 2011, a triatomine was detected in a house located in the Vila Irineu Serra, Rio Branco, state of Acre, Brazil. This state is located in northern Brazil, bordering the states of Amazonas and Rondônia. It has an area of 152,581.4 km^2 equivalent to about 2% of the total area of the country. The climate is hot and humid with average monthly temperatures ranging between 24°C and 27°C. The annual rainfall is 2.100 mm, with a dry season during the months of June, July and August (IBGE 2012).

The residence was located in a periurban area with the presence of secondary forests, palm trees and livestock. The insect was sent to the Laboratory of Entomology of Rio Branco, Acre, and identified as *E. mucronatus* (Figure 1). The identification was confirmed by the Laboratory of Medical Entomology of General Coordination of Public Health Laboratories of the Health Surveillance Secretariat of the Ministry of Health. The specimen is deposited at the Laboratory of Entomology of the Municipal Health Secretariat of Rio Branco, Acre, Brazil.

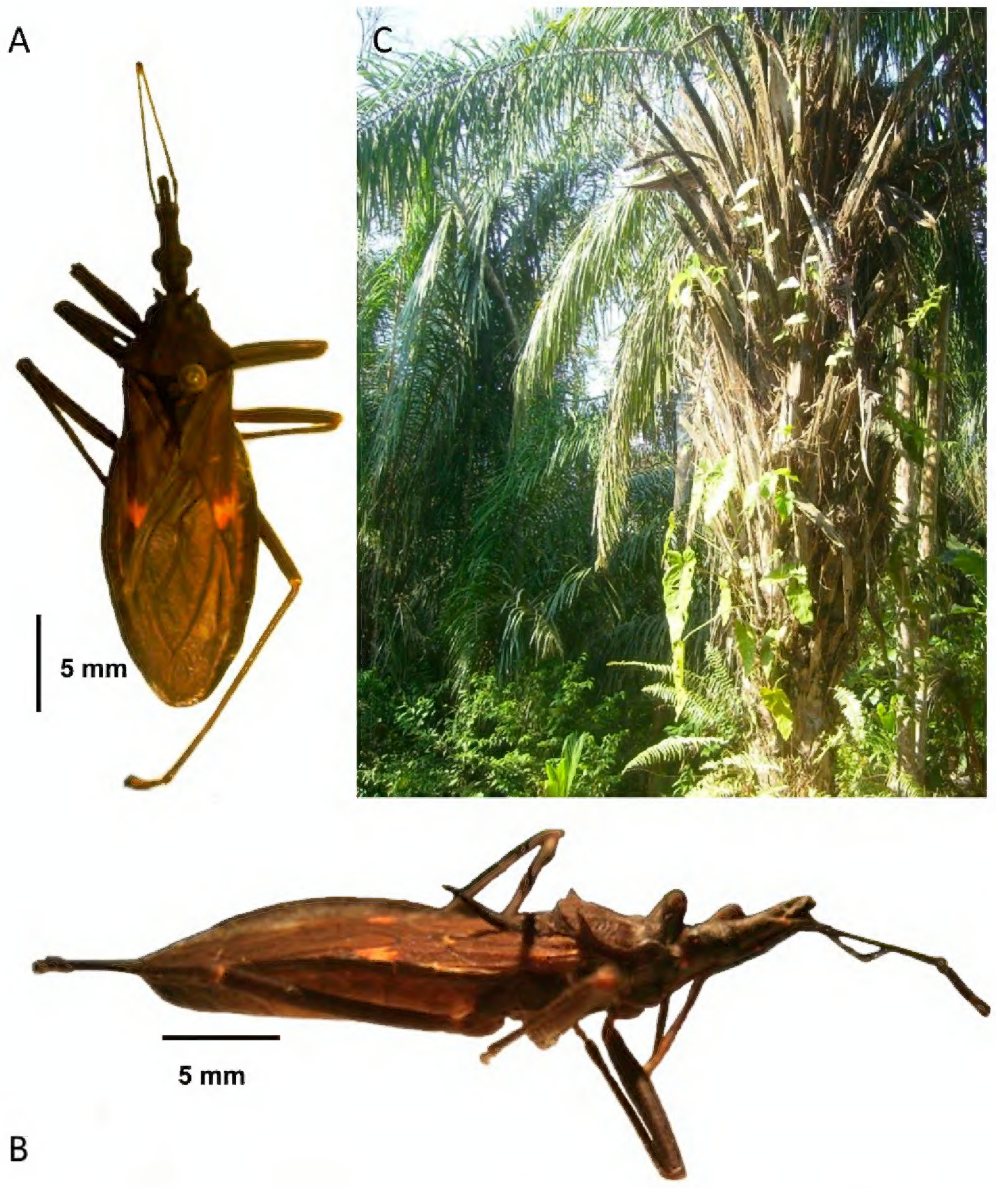

Figure 1. *Eratyrus mucronatus* specimen (male) from municipality of Rio Branco, state of Acre, Brazil. A. dorsal view. B. lateral view. C. *Attalea* palm trees found in the peridomicile of the house where the specimen was detected, probably the natural ecotope of *E. mucronatus*.

Data on the occurrence of *E. mucronatus* were obtained from Lent and Wygodzinsky (1979), Silveira *et al.* (1984), Rebelo *et al.* (1998), Soto Vivas *et al.* (2001), Chávez (2006), Guhl *et al.* (2007), Cortez *et al.* (2007), Rojas *et al.* (2008), Serrano *et al.* (2008), Castro *et al.* (2010), Morocoima *et al.* (2010), Torres and Cabrera (2010), Meneguetti *et al.* (2011), Depickère *et al.* (2012). Records of *E. mucronatus* in collections of Rodolfo Carcavallo and Herman Lent at the National and International Reference Laboratory on Triatomine Taxonomy at the Oswaldo Cruz Institute, FIOCRUZ, were analyzed. The distributional data for *E. mucronatus* available in other museums provided by the Global Biodiversity Information Facility - GBIF (http://data.gbif.org), species link (http://splink.cria.org.br/) and VertNet (http://vertnet.org/index.php) were also analyzed.

In order to develop ecological niche models for *E. mucronatus*, data on climate were obtained from the WorldClim project (http://www.worldclim.org). The environmental data used in the analyses cover South America, at a spatial resolution of 2.5' (5 km). To avoid the confounding effects of calibrating models in an overly dimensional environmental space, only a subset of the 19 variables in the climatic data were chosen: annual mean temperature, mean diurnal range (mean of monthly (max temp - min temp), maximum temperature of warmest month, minimum temperature of coldest month, annual precipitation, precipitation of wettest month, and precipitation of driest month (Gurgel-Gonçalves *et al.* 2012).

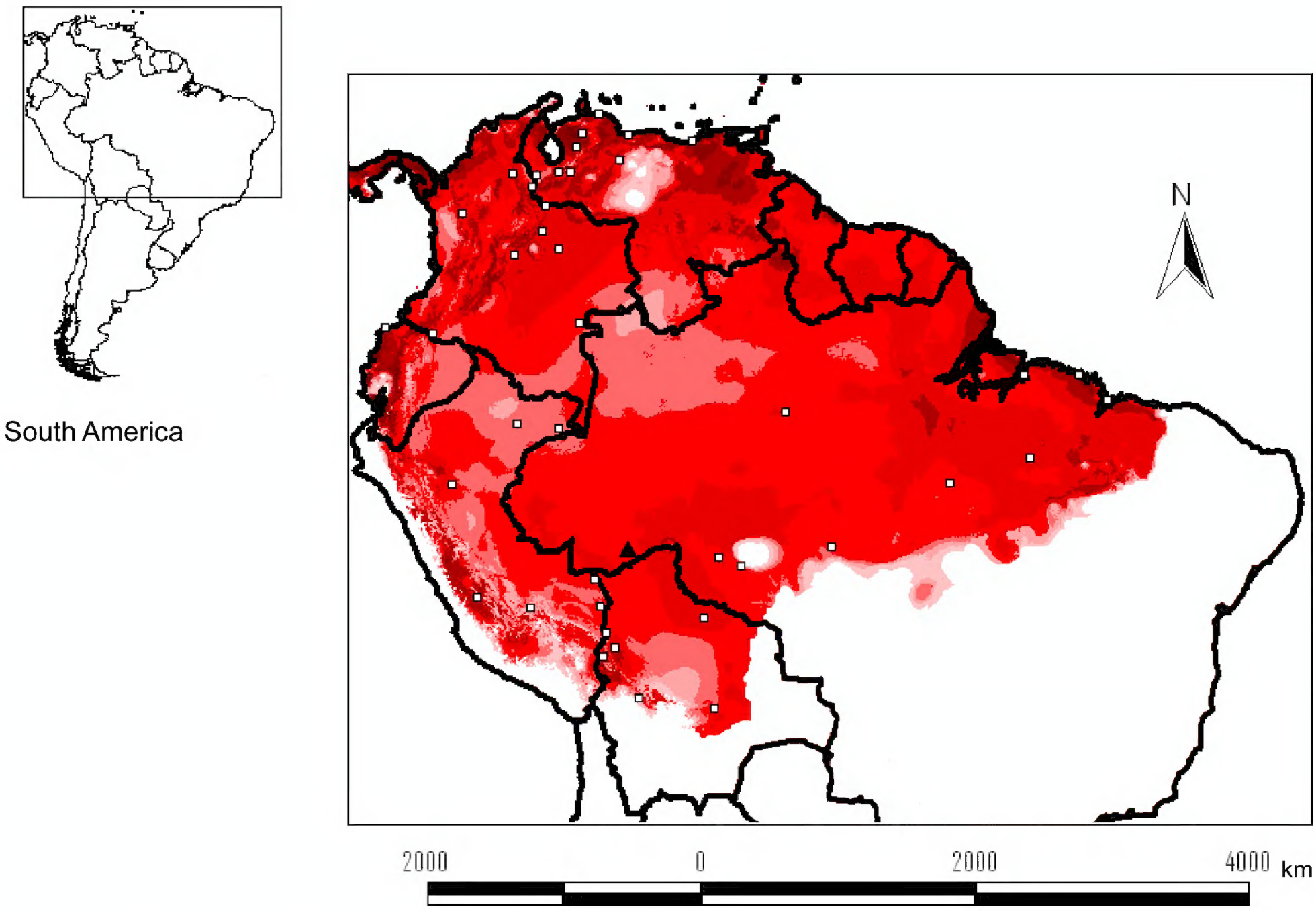

Figure 2. Geographic distribution of *Eratyrus mucronatus* in South America. The squares represent the known records for this species in Venezuela, Colombia, Ecuador, Peru, Bolivia and Brazil. The triangle represents the new record from the state of Acre, Brazil described in the present article. Areas identified as suitable based on climatic variables using ecological niche modeling (Maxent method) are shown in redscale: light red (low suitability) to dark red (high suitability).

Data on a total of 58 occurrences of *E. mucronatus* were assembled. These occurrences were referenced to geographic coordinates with an uncertainty of ≤ 5 km and precision of 0.01°. The records were georeferenced based on data found at http://www.fallingrain.com/world. Occurrence data were separated into two sets: one for model calibration (75% of points) and the other for model evaluation (25% of points). Maps of potential distribution of *E. mucronatus* were produced using Maxent version 3.2.1 (Phillips *et al*. 2006), applying the default parameters with 10 replicates using Bootstrap replication method. Then, the averaged model was imported into ARC VIEW (version 3.2) to create and edit the distribution map. Predicted areas in semi-arid caatinga ecoregion were eliminated in the final edited map.

The quality of the models was evaluated using the ROC (receiver operating characteristic) curve, which correlates the sensitivity and specificity of model predictions across multiple thresholds (Phillips *et al*. 2006). Model accuracy was also assessed by examining the proportion of test points falling into regions of predicted presence (Anderson *et al*. 2002). Using Maxent's internal Jackknife test, the variables that most influence the distribution of triatomine species were identified.

The updated geographic distribution map of *E. mucronatus* (Figure 2) presents the known records in South America and the new record of the state of Acre, Brazil. The ecological niche model indicates that *E. mucronatus* should occur widely in Amazon. The species also showed a potential geographic distribution in drier ecoregions outside the Amazon region, in northern Venezuela and Colombia, such as Maracaibo dry forests, Lara-Falcón dry forests, Paraguana xeric scrub and La Costa xeric shrublands. All of the models derived from the analysis performed well (AUC > 0.92), summarizing the necessary ecological conditions for the occurrence of *E. mucronatus*. All test points fell in the area of predicted presence of *E. mucronatus*. The Jackknife tests showed that precipitation of the wettest month was the variable that best explained the models.

The importance of *E. mucronatus* as a potential vector of *T. cruzi* to humans has been highlighted in Bolivia, Peru and Venezuela (Rojas *et al*. 2008; Torres and Cabrera 2010; Depickère *et al*. 2012). The new record of *E. mucronatus* in domicile in Brazil is further evidence of the synanthropic potential of this species. Ecological niche modeling predicts that *E. mucronatus* is widespread in Amazon, suggesting that the invasion of this species in households must be very common in humid ecoregions of South America.

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